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SPORT ANALYSIS SYSTEMS

Abstract: This article explores various information analysis systems that are used in sports. Some technical features of these systems and basic principles of operation are studied. In the first part, various types of such systems and their scope were analyzed. In the second part of the work, a specific example of the application of a sports analysis system in tennis sports was considered. In the third part, sport analysis systems in TV sports news based on ball detection are studied. An automatic processing of television broadcast is one of the most frequent application of content-based video indexing. TV news and especially TV sports news is one of the most viewed video content on the Web. For effective retrieval of video data not only standard text indexing and retrieval procedures should be used but also more and more sophisticated content-based video indexing and retrieval methods. Because of a huge commercial appeal, sports videos became a dominant application area for video automatic indexing and retrieval nowadays [3].

Keywords: dataset, database, ball detection, video analysis, pattern recognition.

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СИСТЕМЫ СПОРТИВНОГО АНАЛИЗА

Аннотация: В данной статье исследуются различные информационные системы анализа, которые применяются в спорте. Изучаются некоторые технические особенности данных систем и основные принципы работы. В первой части были проанализированы различные виды таких систем и сфера их применения. Во второй части работы был рассмотрен конкретный пример применения системы спортивного анализа в теннисном спорте. В третьей части исследуются системы спортивного анализа в телевизионных спортивных новостях, основанные на обнаружении мяча. Автоматическая обработка телевизионного вещания – одно из самых частых применений контентной индексации видео. ТВ новости и особенно спортивные ТВ новости является одним из самых просматриваемых видеоконтентов в Интернете. Для эффективного поиска видео данных должны использоваться не только стандартные процедуры индексации и поиска текста, но и все более и более сложные методы индексации и поиска видео на основе контента. Из-за огромной коммерческой привлекательности спортивные видео стали в настоящее время доминирующей областью применения для автоматической индексации и поиска видео.

Ключевые слова: набор данных, база данных, обнаружение мяча, видеоанализ, распознавание образов.

One of the difficulties in automated recognition of human activities is classifying a video into a specific action class by selecting among a large number of human actions. Technology for understanding complex and varied human actions is necessary for automated surveillance, sports training, computer games, and human–robot interactions. The difficulty of

classification comes from a dearth of datasets of human actions that are manually categorized and suitable for use as training data for designing action classifiers [3]. The marker-based motion capture system enables precise measurement of human actions for the purpose of analysis. This type of capture systems has several drawbacks, however; in particular, marker-based systems are expensive, intrusive, and complex to use. Despite this, the intensive use of a motion capture system can provide large datasets of human actions, and the datasets may be used to facilitate handling the variety of actions to be classified. Large datasets of human actions measured by motion capture systems are expected to be suitable for the use in classifying video segments into the correct human action category, selecting from among a large number of action categories, and for inferring human postures from video.

Understanding of human action may be approached by different levels of examined details, according to the complexity of each case. Modelling and recognition of human behavior presupposes the labelling and classification of the different kind of actions. According to the action complexity, four basic categories of human action are identified. The first category is the movement of some part of the body, like the rising of a hand (gestures). The second category is characterized by the aggregate movements of one person (actions). Such actions can be walking, jogging, boxing, etc. Interaction is the complex sequence of movements performed by several individuals interfering to each other and may or may not include an object. This comprises the third category while the last one is group activity which actually is a set of activities performed by groups of people. «Queue» is a characteristic example of a group activity.

Marker-based sport analysis systems

Since marker-based optical motion capture systems have been widely used for various applications, such as video games, character animation, sports engineering, and human–robot interaction, a large number of space–time trajectories (more specifically, sequences of positions of markers attached to a performer) have been recorded and accumulated. The positions of these markers can be converted to sequences of joint positions or angles by inverse kinematic computation using a human figure model. The computed scene of a human figure model performing the specific action is projected onto an image plane, and a sequence of images containing the human action can be created by capturing these projections. The association between the sequences of joints positions (or joint angles)

and their corresponding projected images can be used in both action recognition and the recovery of joint positions or angles from a video [3].

Sport analysis system in tennis

Initially, each person repeats each of the above 12 tennis shots 3 to 4 times. This resulted in 660 files of ONI type. Since retention of the relevant data in ONI format files would be qualificatory for wide use, as OpenNI application would be required, conversion of the ONI files to a widely spread format was necessary. Thus, all files have been conversed to AVI format using an algorithm based on OpenNI, developed in our lab. The specific application offers the following features: Isolation of depth data recorded by Kinect's depth sensor. Extraction of the silhouette of the person performing the action. Extraction of the skeleton of the human body through detection of body joints. Illustration of the skeleton relevant data to 2 and 3 dimensions. From every ONI file, 5 synchronized AVI files have been produced:

1. An AVI file that contains the RGB information;
2. An AVI file that contains the depth information;
3. An AVI file that contains the silhouette of the person;
4. An AVI file that contains the movement of the skeleton in 2 dimensions;
5. An AVI file that contains the movement of the skeleton in 3 dimensions.

This results in 3300 AVI files that in following are manually cropped in single actions. The aim of the procedure described above is to receive initial video from every file 3 new ones containing a single repetition of each shot. Thus, 1980 RGB videos, 1980 depth videos and 1980 mask videos (silhouette) have been produced. As far as 2D and 3D skeletons are concerned, these are not always provided for all of the repetitions. This is due to the limitations which appear when one is trying to obtain the skeletons from the initial ONI file. More specifically, each performer has to take initially a calibration pose at the start of the recording. Failing to do so, results in skeleton obtainment failure. Unfortunately, calibration pose was not successful in a few cases and this is something that could have not been checked in advance. Moreover, some of the participants performed some of the shots in extreme high-speed extracting in this way the skeleton, only to later repetitions where the system has managed to calibrate. The number of skeleton videos finally extracted, was 1217 for the 2 dimensions and 1217 for the 3 dimensions accordingly. The summary of the contents of each folder is the following:

1. Video RGB: contains 1980 AVI files;
2. Video Depth: contains 1980 AVI files;
3. Video Mask: contains 1980 AVI files;
4. Video Skelet2D: 1217 AVI files;
5. Video Skelet3D 1217 AVI files;
6. txt: detailed description of the contents of each folder of the dataset [2].

Sport analysis system in TV sports news based on ball detection

Content-based indexing of TV sports news is based on the automatic temporal segmentation, recognition, and then classification of player shots and scenes reporting the sports events in different disciplines. Automatic categorization of sports in TV sports news is a basic process in video indexing. Many strategies how to recognize a sports discipline have been proposed. It may be achieved by player scenes analyses leading to the detection of playing fields, of superimposed text like player or team names, identification of player faces, detection of lines typical for a given playing field and for a given sports discipline, recognition of player and audience emotions, and also detection of sports objects specific for a given sports category.

To discriminate balls from the ball-like objects additional criteria should be applied. These additional filters should be rather restrictive because the sports video categorization does not require to analyze successfully all frames or even all shots of a given scene and to detect an extremely small ball, difficult to see. It is enough to detect even only several frames but with very height probability enabling to recognize the sports category. Detections are assumed to be false if:

1. in one frame three or more objects have been detected as balls;
2. an object detected as a ball is at the same position in more than ten consecutive frames – in sports news the player shots are very dynamic;
3. it is a simple detection in 100 consecutive frames.

The next criterion will be a colour of a ball. The colours of balls in ball sports are defined formally by the sports rules. The tennis balls are yellow, the colour of basket balls is brown. Unfortunately, the colours of small balls in tennis videos are not pure yellow. The colour hue changes because of the changes in lighting and the camera distance. Therefore, it is desirable to determine the range of variation of a ball colour [1].

In conclusion, it is necessary to underline that modern sport analysis systems are important not only for sportsmen and their coaches, sport

achievements and competition results, but also for the development of sport science.

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